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PROCEEDINGS
OF
The American Microscopical Society.

FIFTEENTH ANNUAL MEETING.

ADDRESS OF THE PRESIDENT:

THE RELATION OF THE MICROSCOPE TO THE ADMINISTRATION OF JUSTICE.

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I do not think I shall be disputed by any thoughtful person in the statement that there is no more honorable calling than the administration of justice according to law between man and man. If, then, I can show that the microscope is an important agency or adjunct in this calling, I shall have done something, at least, toward the payment of that debt which every man owes to his profession.

In considering this question it is well at the outset to consider some of the limitations and conditions attending the ordinary administration of justice which may affect or perhaps rarely invalidate the conclusion reached. These infirmities are not peculiar to cases involving scientific testimony, but affect every case depending upon ordinary parol evidence, and affect ordinary issues of fact perhaps quite as much as those depending upon expert testimony. Until all judges, jurors, and attorneys are composed of men of scientific education, it is too much to expect perfect results. It should be borne in mind that the law does not, as a rule, deal with questions of fact capable of absolute demonstration, as is the case with mathematical truths, but that moral certainty or a high degree of probability is all that can in reason be expected. This infirmity, if such it be, inheres both in the tribunal and in the subject-matter that comes before it for adjudication.

Of all the different sorts of evidence that are offered in courts of justice in support of different sorts of cases, unless, perhaps, we except record evidence, the evidence offered by the microscope, in the hands of a competent and honest observer, is quite as satisfactory as any other kind of evidence and is often conclusive, when without it the decision must at the best be merely speculative. This is perhaps not the place for the discussion of the subject of expert testimony. Much evidence under our system is offered and received that is neither expert nor honest. We are not of those who believe that the defects of the present system can be remedied by the adoption of the system prevailing in continental Europe, so long as judges and juries have not greater powers of scientific discrimination.

The best remedy at our disposal under the present system is that great test of truth—intelligent and skillful cross-examination conducted by counsel thoroughly conversant with the subject in controversy. In order to be able to withstand such cross-examination, not only is the most careful and conscientious preparation on the part of the expert necessary, but the utmost conservatism and care in the statement of facts and conclusions. In this connection I wish to emphasize the necessity of scientific conservatism or agnosticism, in the better sense of the word, which does not jump at conclusions but arrives at them after patient and laborious induction. The habit, too prevalent, of making extravagant and unfounded claims for the results arrived at by the use of the microscope in legal microscopy is responsible, in my opinion, for much of the reproach unjustly cast upon microscopists as a body and especially upon those who are called as experts in the courts. Some of these extravagant claims will be hereafter referred to and' fully justify the strictures of an editorial published in the Chicago Evening Journal September 9, 1891, entitled "The Charlatanry of Microscopy," in which, among other things, the writer says:

"There is one interesting difference between astronomy and microscopy. The astronomer is never a humbug, but the same cannot be said of the microscopist. The astronomer is never a hired witness in a court of justice, and that is the highest ambition of the microscopist.''

The writer then observes, with a refinement of sarcasm which I am sure this body will appreciate:

'' Consequently, the astronomer is generally an honest old fellow with seedy clothes and an empty pocket-book, while the microscopist is sleek and prosperous and is strongly tempted to be a charlatan. His evidence is very unreliable, from circumstances beyond his control, such as the peculiarities of his own eyes and the blundering unscientific qualities of his own mind ; but it is to be feared that his vision is also sometimes distorted by something else than the inequalities of his crystalline lens and the undue refractive power of his vitreous humor,'' etc.

The writer then proceeds to make a somewhat personal application of the foregoing remarks to the celebrated Davis will case, which it is not necessary here to repeat.

I shall now proceed briefly to call your attention to some of the cases in which the microscope has been called into requisition in the courts.

As to the identification of tissues as human, questions not unfrequently arise. A little over two years since an article appeared in the American Monthly Microscopical Journal, which was copied in the English Mechanic, in which the writer, Dr. Gaertner of Pittsburg, stated that by the aid of the microscope brain matter was identified as such in the celebrated Dr. Cronin case tried in Chicago some years since. It is to be regretted that any writer should be betrayed into making such notoriously incorrect statements, which can only tend to bring the cause of science, as represented by the microscope, into contempt; for not only did the question not arise in that case, but the evidence, which was not contradicted on this point, was that the body was not discovered until eighteen days after the murder and that the brain was then completely disorganized, so that not even gross lesions could be made out by its inspection. The inner surface of the skull was not injured, so that even if it had not been thus disorganized no question of this sort would be likely to arise.*

Orfila was the first to direct the attention of medical jurists to the identification of cerebral matter and proposed the application of certain chemical tests to dried spots alleged to be brain substance.* M. Robin, so far as I can learn, was the first to employ the microscope for this purpose (1 Taylor, 526), with, as it seems, better results than with the chemical method. Only competent observers should, however, venture to express an opinion in such a case, for in a case of murder recorded by Dr. Taylor (1 Juris., 526), in which the deceased had sustained severe injuries to the head, an expert professed to have discovered with the stains of blood on cloth a quantity of brain substance. The autopsy, however, as in the Cronin case, revealed the fact that although the skull had been fractured the cavity had not been opened and no brain had escaped. Dr. Taylor, therefore, expresses the opinion that at that writing no reliance could be placed on tests for this tissue. Much would depend, however, on the condition of the tissue, and each case should, as it seems, be judged by its own facts. The same statement may be made as to the other soft tissues of the body.

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*See abstract of the record in the Cronin case on file in the Supreme Court of Illinois, vol. ii, p. 20.

Bones, hair, and teeth may doubtless be identified as such, but I know of no criterion by which bone may be identified as human by the use of the microscope.

Cases have arisen in which the presence of hairs or fibers found adhering to a weapon has been relied upon as furnishing evidence of guilt, and the case may turn on the identification of such fibers. A case is quoted by Dr. Lyons, in which a hatchet having clotted blood and hair adhering to it was produced as evidence against the accused, under whose bed the weapon had been found. This, with other circumstantial evidence, had turned public opinion (so often founded on insufficient evidence) strongly against the accused. A microscopical examination, however, showed that the hair was not human and the prisoner was acquitted.†

As respects the identification of hair and other fibers by means of the microscope, it is undoubtedly true that most mature hairs and fibers, when a sufficient number are available for examination, can be thus identified. It is nevertheless equally true that a given human hair cannot always be certainly distinguished by such means from the hair of all other animals, and especially is this true of some sorts of dogs' hair. Each case must stand upon its own facts, and in most cases as they arise a satisfactory conclusion can usually be reached.

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* Ann. d'Hyg., 1850, 2, 143; 1 Taylor's Med. Juris., 2d ed., 525.

† Taylor's Med. Juris., 2d ed., 508 *et seq.*, where will be found several other interesting cases involving similar questions.

The identification of blood stains in cases of alleged murder has afforded a fruitful field for controversy in the past, and the question is not yet entirely settled. Many methods have been proposed for such identification. Early in this century (1829) prominent medico-legal jurists, when called to testify on the trial of persons accused of murder, testified that by the sense of smell blood could be identified when treated with from one-half to one-third its bulk of sulphuric acid.

More recently it has been claimed that blood could be identified by the so-called "blood pictures" caused by the evaporation of a solution of its red coloring matter upon glass.

Again it has been claimed that it could be identified by a comparison of the forms of hæmatin crystals. It seems unnecessary to state that these methods are now entirely abandoned.

Among the methods still in use to a greater or less extent may be mentioned Teichmann's process by obtaining hæmin crystals. This method, however, often fails.

The guaiacum test is still used to some extent, and in connection with other tests will often be found useful, but is open to some fallacies.

Among the tests which are not open to fallacy is the spectroscopic test, by the comparison of blood spectra. This test, however, only identifies blood as being mammalian blood and does not serve to identify the animal from which it came. In this connection the recent test proposed by Dr. S. Monckton Copeman, of England, should be mentioned. This test has not, however, been sufficiently long in use to enable one to speak of its merits.

Another test is the identification of red blood corpuscles by means of the microscope. Whenever circular, non-nucleated blood corpuscles are thus found, their presence is proof of mammalian blood. Ever since 1846 it has been claimed with more or less positiveness that with certain limitations the different species of mammalian blood can be positively identified by the micrometrical measurement of the red corpuscles. The late Dr. Richardson of Philadelphia, was the most prominent advocate of this claim; and lately the claim has been renewed by the late Dr. Formad of the same city, with even more positiveness than by Dr. Richardson. I have myself, some nine years since, heard a then well-known expert profess not only his ability to distinguish human blood from that of all other animals, but even to identify the particular person from whom the blood was shed. The celebrated controversy between Dr. Richardson and Dr. Woodward is probably fresh in the recollection of most readers. Dr. Richardson has stated, however, in an article published in volume 13 of the Monthly Microscopical Journal (London), on page 215, that so far as he was aware there was in 1875 "no method known to science, microscopical or otherwise, for distinguishing the blood of the dog, monkey, rabbit, musk-rat, elephant, lion, whale, seal, or in fact any mammal whose corpuscles measure more than $\frac{1}{4000}$ of an inch in diameter."

Thus stood the controversy until 1888, when Dr. Formad, on page 28 of his "Essay on Comparative Studies of Mammalian Blood," refers to the work of Dr. Richardson in the following terms: "He was one of the most prominent advocates of the positive diagnosis of human blood from that of *all* domestic animals by means of micrometry under high amplification." Again, on page 29 he uses this language: "Surely human blood can be told from that of all domestic animals, not counting the guinea-pig as a domestic animal. It depends, however, on whose figures are accepted for the mean diameter of this animal's corpuscles whether the guinea-pig's blood may be mistaken for human." The above quotation from the article by Dr. Richardson seems quite unambiguous, but it does not seem to warrant the statement of Dr. Formad, above quoted.

This question has engaged the attention of the writer a considerable portion of his leisure since 1885. Without repeating here in detail what I have written upon this subject in another place,* I may summarize the conclusions I then arrived at, which in the light of subsequent experience I have seen no reason to modify, as follows:

(1.) The only proposed methods of identifying blood that are worthy of discussion are (*a*) Teichmann's process of obtaining hæmin crystals, (*b*) the Guaiacum test, (*c*) the Spectroscopic test, (*d*) the microscopic identification of red blood corpuscles, and (*e*) the micrometric test. The last method only will be here discussed.

(2.) In the use of the micrometric test no confidence can be placed in the result, unless the errors of the micrometer used, with reference to some authentic standard, are known. Instruments used in this investigation and methods fully described in the paper above referred to.

(3.) Where the subject continues during a *short* period in substantially the same condition of good health, there appears in the hands of the same observer to be an average size of the *fresh corpuscles*, provided at least 100 corpuscles are measured.

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*See North American Practitioner, Chicago, March and April, 1890; Medico-Legal Journal, October, 1892.

(4.) There are such large discrepancies between the averages obtained from the measurement of the *fresh* blood corpuscles of animals of the same species and between measurements of the same objects by different observers as to throw doubt upon published results. Several tables of measurements are given in said paper to prove this statement.

(5.) There is no advantage in using very high powers in such investigations.

(6.) Drying of the blood corpuscles in a clot multiplies the difficulty of identification. It has never been proved that dried corpuscles can be restored to their normal proportions.

(7.) The mean size of the red corpuscles of very young animals is larger, and their size varies between wider limits than in adults.

(8.) Many diseases alter the size of the red corpuscles; especially is this so in microcythæmia.

(9.) Fasting diminishes both the size and number of the red blood corpuscles. So also in the case of various drugs.

(10.) In view of the foregoing, it is impossible in the present state of science to say of a given specimen of blood, fresh or dry, more than that it is or is not the blood of a mammal.

At a recent meeting of the New York Medico-Legal Society a paper was read by Mr. Clark Bell upon the subject "Blood and Blood Stains," which was discussed by Dr. Robert Reyburn, Dr. Ira Van Giesen, Mr. Charles Ernest Pellew, and others. With reference to the guaiacum test Mr. Pellew is reported to have claimed and demonstrated that it could not be regarded as a reliable one in all respects and demonstrated that he could produce the same blue color by the use of the same re-agents on various substances besides blood, and obtained such a result upon the inside of a common raw potato.

He conceded, however, that this test could be relied upon:

"(1.) If tried on stains resembling blood stains and the blue color was not produced, it was conclusive that the stains did not contain blood.

"(2.) That upon blood or blood stains the slightest particle or shred, no matter how minute, under this test would produce the beautiful blue color almost instantly.

"(3.) But that, as other substances beside blood produce the same color and results, it could not be certainly stated that when the blue color resulted that this result was certain evidence of the existence of blood."

According to Mr. Bell's report the consensus of opinion favored the following propositions:

"(1.) That there is no difficulty in distinguishing between human blood and that of birds, fishes, and amphibia generally.

"(2.) That by careful and competent observers, with instruments of high power, a reliable discrimination can be made between human blood and the blood of mammals, when the size of the red corpuscles is much smaller than that of man, notably in the case of the ox, the horse, the goat, the sheep, the pig, and most mammals.

"(3.) That the blood of the dog, the rabbit, and the guinea-pig so nearly resembles human blood in the size or diameter of the red corpuscles that it is more difficult to identify it, and divided opinions exist among observers, Professors Reese, Formad, Reyburn, and others claiming that by the employment of instruments of high powers, up to 10,000 diameters, the differences in diameter become so great when thus magnified as to make it apparent in all mammals except the guinea-pig and opossum, while Professor Ewell and others deny that the results of these investigations are such as to make it certain and absolute when in doubtful cases human life is at stake.

"(4.) All concurred in asserting positively '*that the blood examined is consistent with human blood,*' if unwilling to state positively that it is such, or agreeing with the dictum of Professor Wormley in his treatise that '*the microscope may enable us to determine with great certainty that a blood is not that of a certain animal and is consistent with the blood of man,*' although some might agree and some dissent from the same author's assertion, added to the above quotation: '*but in no instance does it in itself enable us to say that the blood is really human or indicate from what peculiar species or animal it was derived.*' "

With the first of the above propositions I quite agree, provided, of course, that the blood corpuscles can be distinctly made out.

From the second proposition, for the reasons given in the paper before referred to, I must emphatically dissent. I have demonstrated (to my own satisfaction, at least), in a paper presented at a former meeting of this Society, that definition is more important than high amplification, and that there is no advantage gained in the use of high powers, as claimed by Dr. Richardson and others; and especially is this so where, as in the paper of Dr. Formad, it appears from his illustrations that amplification is pushed to such an extent as to destroy definition and leave the margin of the corpuscle to be measured a nebulous patch, whose beginning and ending it is impossible to determine. With reference to the other propositions I do not concur with the dictum of Dr. Wormley above quoted that the microscope may enable us to determine with great certainty that a blood is not that of a certain animal unless, indeed, it be one of the camel family. The very utmost the present state of science enables us to state is that the blood in question is or is not that of a mammal, a bird, fish, or reptile. To say more than this is, in my judgment, without warrant to imperil human life, and, in the words of the late Dr. Woodward, to make scientific experts more dangerous to society than the very criminals they are called upon to convict.

Spermatozoa can usually be identified by means of the microscope with a high degree of certainty, and not unfrequently such identification may be an important link in the chain of evidence by which a criminal is brought to justice.

With the microscope one skilled in that department of learning can also usually settle beyond controversy questions involving the adulteration of food and drugs.

In gunshot wounds, the examination of wadding or paper found in a wound or near a dead body has not unfrequently aided in the conviction of a criminal.* These cases arose before the use of modern breech-loading guns, and the same questions are not so likely now to arise. But where, as is often now the case in felonious homicides, a projectile is found in the body, it may be material to identify it as having been fired from a certain gun by micrometric measurements of its caliber and the dimensions of the grooves appearing on the projectile, which are frequently as distinct as if the ball had been swaged in the barrel instead of having been fired from it. This is especially the case with modern projectiles highly alloyed with tin, and presumably also with the new small-calibered projectiles jacketed with a thin shell of some harder metal.

In the case of Moore, recorded in 1 Taylor's Med. Juris., second edition, page 516, it was proved that the throat of deceased had been cut through to the spinal column, and imbedded in the muscles and bones were found several particles of metal, which a microscopical examination identified as portions of steel forming part of the edge of a cutting instrument. In the possession of the accused was found a blood-stained razor, the edge of which presented several notches corresponding to the pieces of steel found in the neck of deceased. The crime was thus fixed on the accused and the theory of suicide negatived.

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* See cases cited in 1 Taylor's Med. Juris., 2d ed., p. 514.

In another case (The Queen *vs.* Snipe *et al.*, York Winter Assizes, 1852) a microscopical examination of dried spots of mud. on the boots and clothes of the prisoner revealed the presence therein of infusorial shells, some rare aquatic vegetables, particles of soap, confervæ and hairs from the seeds of the groundsel. The mud of a ditch near where the body of deceased was found presented the same microscopical appearances, and the expert testified that in his opinion the mud spots were derived from this ditch, it appearing from examination that the mud of all the other ditches in the locality was different. This evidence standing alone would not warrant a conviction, but furnished an important link in the chain of evidence leading to that result.*

In several cases involving large sums of money the attempt has recently been made to identify ink upon the paper by observing it with the compound microscope alone. Notably was this the case in the Dempsey will case at Hackensack, N. J., and in the celebrated Davis will case at Butte, Montana. Undoubtedly some isolated cases may occur in which a very close guess can be made as to the nature of the ink by a naked-eye inspection alone or by an examination with a hand lens. So far as I can see, there is no real advantage in such cases in using a compound microscope, and in my opinion its use in such cases is an unnecessary refinement and in some instances misleading. Further than this, I venture the assertion, which is borne out by the results in the cases above referred to, in which the chemical tests invalidated the claims based upon a mere microscopical examination, that the chemical constitution of ink cannot be satisfactorily made out by the use of the microscope alone, but can only be settled by chemical tests or by a spectroscopic examination. I have made a large number of tests with the spectroscope, with quite satisfactory results, which I purpose bringing to your attention in another paper, and I therefore state with some confidence that in the present state of scientific knowledge the chemical constitution of ink can only be made out by a chemical or spectroscopic examination or by both combined.

It occasionally is necessary in the administration of justice to determine the constituents of the paper upon which a document is written or printed, it being possible sometimes thereby to determine approximately the time of its manufacture from a knowledge of its constituents. Suppose, for instance, that a document should be produced purporting to have been executed at a time before wood pulp was invented and in use in the manufacture of paper. In such a case the discovery of wood pulp in the paper would be conclusive evidence of the fraudulent nature of the instrument. The microscope in such a case furnishes the most efficient means of demonstrating this fact.

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* 1 Taylor's Med. Juris., 2d ed., pp. 521, 522.

Again, in the investigation of writings alleged to be forgeries the microscope not unfrequently furnishes an efficient means of detecting the fraud. It is rare, however, that a high power is necessary for this purpose, and more frequently the most efficient aid is derived from a globe lens or an achromatic triplet magnifying from 10 to 15 diameters, with which, as a rule, though there are exceptions, every thing can be seen which it is necessary to see in the administration of justice in such cases.

I shall not longer weary your patience by the citation of instances which might easily be multiplied. The above will suffice to show that the limits to the use of the microscope in the administration of justice are not circumscribed, but are continually widening with the increasing refinements of modern civilization. The forensic microscopist should not, however, be arrogant, for microscopy is only one of many scientific agencies which should go hand in hand in advancing the cause of justice. Lord Coke truly observed that in the ashes of the law lie buried the sparks of all sciences, which in these modern times may with equal propriety be stated to have been fanned into flame for the enlightenment of justice.